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Director's Review of Run II Luminosity Plan

Instrumentation

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Outline

- Who is instrumentation
- What do we do
- List of Run II work
- Significant Projects for Run II
- Distractions from Run II
- Summary



Instrumentation Department

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- Under new management
 - Bob Webber will become the department head on November 1
- Resources
 - 3 Guest Scientists
 - 6 Electrical Engineers
 - 1 Engineering Physicist
 - 1 Engineering Associate
 - 4 Programmers
 - 9 Technicians
 - 25 total (+Bob)



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Instrumentation Devices

- General Instrumentation
 - 1359 Beam Position Monitors (BPM)
 - 1004 Beam Loss Monitors (BLM)
 - 62 Multi-wires (slow profile monitors)
 - 10 Flying wires (few msec profile monitors)
 - 5 Ionization Profile Monitors (IPM, turn by turn profile monitor)
 - 20 Toroids (transfer line beam intensity)
 - 3 DC beam intensity monitors (DCCT)



Instrumentation Special Devices

- Special Devices
 - 3 Fast Bunch Integrators (FBI)
 - Bunch intensities at up to 360Hz
 - 2 Sampled Bunch Display (SBD)
 - Bunch intensities and longitudinal profile, few seconds, uses oscilloscope
 - 6 Beam Line Tuners (BLT)
 - Measure transverse injection errors using turn by turn positions
 - 1 Synchrotron Light Monitor (Synch Light)
 - 4 Schottky tune Monitors
 - Dampers?
 - Longitudinal, transverse, transverse injection



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List Run II Work

- Proton Source
 - Longitudinal Dampers
- Main Injector
 - Longitudinal Dampers
 - Transverse Injection Dampers
 - 2.5 Mhz BPM's
 - Beam Line Tuner
- Tevatron
 - Transverse Dampers
 - Transverse Injection Dampers
 - Longitudinal Dampers
 - Schottky detector at E17
 - Synchrotron Light monitor
 - New BPM's?



List Run II Work continued

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- Recycler
 - Longitudinal Dampers
 - Transverse Injection Dampers
 - BPM upgrade
 - Flying wires
 - Beam Line Tuner
 - Schottky Monitor
- Pbar Source
 - Accumulator Flying wires
- RR eCooling
 - Electron beam modulation driver
- Tev eLens
 - Beam Position Monitors
 - Electron beam current analysis



Recycler BPM upgrade

- Present Recycler BPM's
 - Use Logarithmic amplifiers
 - measure 3rd harmonic of the 2.5MHz beam modulation frequency
 - Detector resonates at 7.5MHz
 - Plate to plate coupling, quality of the log amp, and time dependence make them unreliable
- Proposed upgrade
 - Commercial boards (EchoTek GC814)
 - 80 MHz 14 bit converter with a digital down converter
 - 4 beam positions in each \$7.5K card
 - Uses 85% of existing front end software
- Have 4 channels of the digital down converter working and will install another 4 at the next tunnel access
 - They look very good!



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Main Injector BPM's

- Currently using old Main Ring BPM electronics
 - AM/PM conversion designed to work with continuous 53MHz bunches
 - Cannot measure 2.5MHz bunch structure (pbars)
 - System is 20 years old
 - difficult to maintain Z80 machine language code
 - Controls does not want to support “GASP” speaking front end
 - Spare parts are difficult to obtain
- Could upgrade to same commercial digital down converter being proposed for the Recycler BPM's
- Dynamic range, fidelity, adaptability are significantly better
- Exploit most of the software from Recycler and use common spare parts



Beam Line Tuners

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- Required in Main Injector, Tevatron, and Recycler
- Measure horizontal and vertical position for the first 1024 turns
- Used to calculate position and angle injection errors
- Make corrections for subsequent injections to avoid dilution or emittance growth
- Tevatron
 - Using fast digital oscilloscope to measure individual bunch positions
- Main Injector
 - Need to improve existing system to work with 2.5MHz bunch structure
- Recycler
 - Just completing BLT using commercial digital receiver cards
 - Currently using hardware on loan from SLAC, plan to switch to bpm upgrade hardware



Dampers

- Damp betatron or synchrotron oscillations
 - Measure position/phase and change angle/momentum
 - Damp instabilities, allow running with lower chromaticity
- Required in Booster, Main Injector, Tevatron, Recycler
 - Longitudinal
 - Transverse
 - Transverse Injection
- Several groups are working simultaneously
- Booster – Bill Pellico
 - Improving Longitudinal dampers to reduce noise and make them easier to maintain



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Dampers continued

- Tevatron: Jim Steimel, Cheng-yang Tan in Tevatron
 - Longitudinal damper done
 - Horizontal transverse damper is working
 - Vertical should come on line shortly
 - Injection dampers are being procured/assembled
- Recycler, Main Injector:
 - Dave Wildman, Bill Ashmanskas, Bill Foster
 - Use commercially available VME digitizer card
 - 14 bits 100MHz
 - Large FPGA to make digital filters
 - Just getting started



Schottky Monitors

- Used in Recycler and Tevatron (storage machines)
- Measure longitudinal and transverse beam spectra with slotted waveguide detector
- Widths of tune lines are used to measure longitudinal and transverse emittance and chromaticity
- The Tevatron version will be gated to allow individual bunch measurements
- Ralph Pasquinelli and Ed Cullerton are close to completing these devices.



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Synchrotron Light

- A synchrotron light profile monitor is installed in the Tevatron
- Harry Chung and Eugene Lorman are upgrading the system from NUBUSS to PCI format using a faster processor
- Uses a CID camera and an optical telescope to get the image of the synchrotron light as beam enters a dipole
- Works above 600 GeV beam energy
- Commercial image processing software is combined with LabView to extract transverse profiles
- Does not degrade the beam and can measure profiles of individual bunches (about 2 profiles/sec)



Ionization Profile Monitors

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- Ions generated by the beam from residual gas molecules are accelerated to a micro channel plate. The resulting charge is collected on an array of conducting strips and an image of the beam profile is reconstructed
- Produces profiles on each turn and works at all beam energies and does not degrade the beam
- The speed of these devices make them attractive but some physics issues need to be resolved
- Profiles are not well calibrated but qualitative measurements are enticing



Flying Wires

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- Measure transverse profiles in circulating beam
- Move single wire through the beam at 10 m/s and measure losses
- Need to upgrade Pbar Accumulator wires
- Recycler has requested a set of flying wires
- Migrate from NUBUS to compact PCI format
- Investigate “Labview RT”
 - Proprietary real time operating system
 - Runs on IBM/Windows compatible machine
- Design new RIP FIFO card (Resolver and wire Position FIFO)
- Design new photo multiplier loss monitor
 - Fewer gain stages to optimize linearity
 - Switchable light attenuator to improve dynamic range



Multiwires

- Grid of 48 horizontal and 48 vertical wires used to measure beam profiles in transfer lines
 - (Too much mass to use in circulating beam)
- Recently Installed 8 new multi-wires in the Recycler - Main Injector transfer lines
 - Need to repair 2 of them
 - Need to use external timing to narrow integrate window and reduce noise
- A1 transfer line multi-wires (pbar from MI to Tev)
 - Replace 1mm grids with 0.5mm grids (6 multi-wires)
- P1 transfer line multi-wires
 - This transfer line works at 8, 120, and 150 GeV (large range of beam size)
 - Replace 6 multi-wires with dual pitch grids



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Distractions

- Miniboone (done)
 - 18 Beam Position Monitors (BPM)
 - 18 Beam Loss Monitors (BLM)
 - 3 Total Beam Loss Monitors
 - 2 Toroids
 - 1 Wide Bandwidth Resistive Wall Monitor
 - 1 Beam present detector
 - 7 Multi-wires
 - Special Target Instrumentation
 - Target Profile Monitor



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Distractions continued

- Switch Yard 120 (75% done)
 - 44 Resonant Beam Position Monitors (BPM)
 - Move cables, establish RF clock, Re-tune
 - 63 Beam loss monitors (BLM)
 - Move, extend, repair cables
 - 12 Swics
 - Move, extend, repair cables
 - 6 New Multi-wires



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Distractions continued

- NUMI (to do)
 - 25 Beam Position Monitors (BPM)
 - 33 Beam Loss Monitors (BLM)
 - 4 Total Beam Loss Monitors
 - 10 Multi-wires
 - 2 Toroids
 - Move Main Injector instrumentation at MI60 to make room for NUMI kickers



Summary

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- Recycler problems have used more instrumentation resources than expected
- Miniboone, Numi, and SY120 demand significant effort
- The instrumentation department has more work than it can do
- Bill Foster is leading a substantial effort to build Recycler and Main Injector dampers
- Stephen Pordes has brought much needed help from the Particle Physics Division
- People from the Computing and Technical divisions have also “volunteered” to help
- All Run II projects have been assigned, resources are being allocated as needed to complete them in a timely fashion